What is claimed is:

1. A method for automatically predicting and preventing the electrographic onset of a seizure in an individual, comprising the acts of:

monitoring a plurality of signals indicative of the activity of the brain of the individual;

extracting a set of features from the signals and forming an optimal feature vector;

synthesizing a probability vector based on the optimal feature vector as an estimator of the likelihood of seizure for a plurality of prediction time intervals; and

preventing the electrographic onset of a seizure by the automatic application of at least one intervention measure that is commensurate with the likelihood of seizure.

2. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 1 further comprising the act of displaying the probability vector of oncoming seizures for a plurality of prediction time intervals to indicate both the time frame when the electrographic onsets are expected to occur and a degree of confidence in the predictions of electrographic onsets.

3. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 1 wherein the act of preventing the electrographic onset of seizures automatically applies the minimally required intervention measure thereby minimizing associated side effects.

4. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 3 wherein the minimally required intervention measure starts with a benign form of therapy and continues with more aggressive therapies as the probability vector continuously changes with decreasing time to electrographic onset.

5. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 3 wherein the minimally required intervention measure couples minimally invasive benign therapies to long prediction time intervals, aggressive therapies to short prediction time intervals and gradually varying moderate forms of therapy to prediction time intervals that are between the long and short prediction time intervals.

6. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 5 wherein the minimally required intervention measure applied matches the tolerance for false positive and false negative prediction errors for each prediction time interval.

7. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 1 wherein the intervention measure includes at least one of cognitive stimulation, sensory stimulation, biofeedback, electrical stimulation and pharmacological infusion.

8. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 1 further comprising the act of applying a closed loop feedback control law and commanding a therapy actuator in order to regulate the seizure probability vector.

9. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 8 wherein the applied closed loop feedback control law and therapy actuator includes any of a proportional, proportional-integral-derivative (PID), optimal continuous, gain scheduled, multilevel and bang-bang control strategies to regulate the seizure probability vector as a controlled variable.

10. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 6 wherein the intervention measure is triggered by prediction thresholds with high sensitivity and low specificity.

11. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 1 wherein the intervention measure is delivered in at least one of a region of onset and a distribution region surrounding the region of offset.

12. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 1 wherein the intervention measure is delivered in subcortical regions including at least one of the thalamus, basal ganglia, and other deep nuclei.

13. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 1 wherein if the electrograhic onset occurs, applying treatment to either at least one of a general region of onset and deep brain structures to modulate the behavior of the seizure focus.

14. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 1 wherein the intervention measure application includes at least one of:

rhythmic electrical pacing that changes in frequency, intensity and distribution as the probability of a seizure onset reaches and exceeds a threshold;

chaos control pacing;

random electrical stimulation to interfere with developing coherence in activity in a region of, and surrounding, an epileptic focus;

depolarization or hyperpolarization stimuli to silence or suppress activity in actively discharging regions, or regions at risk for seizure spread.

15. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 14 wherein the intervention measure is delivered to a plurality of electrodes to provide a surround inhibition to prevent a progression of a seizure precursor.

16. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 14 wherein the intervention measure is delivered sequentially in a wave that covers a cortical or subcortical region of tissue so as to progressively inhibit normal or pathological neuronal function in the covered region.

17. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 1 wherein the intervention measure application is an infusion of a therapeutic chemical agent into a brain region where seizures are generated, or to which they may spread.

18. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 17 wherein the chemical agent is delivered in greater quantity, concentration or spatial distribution as the probability of seizure increases.

19. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 17 wherein the intervention measure is applied to at least one of an epilectic focus, an area surrounding the epilectic focus, a region involved in an early spread, and a central or deep brain region to modulate seizure propagation.

20. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 17 wherein the therapeutic chemical agent is activated by oxidative

stress and increases in concentration and distribution as the probability of seizure increases.

21. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 1 wherein the intervention measure is delivered to central nerves or blood vessels in a graduated manner as the probability of seizure increases.

22. The method for automatically predicting and preventing the electrographic onset of a seizure of claim 1 wherein the intervention measure is a plurality of artificial neuronal signals delivered to disrupt eletrochemical traffic on at least one neuronal network that includes or communicates with an ictal onset zone.

23. A method for assessing a quality of life index in an individual subject to seizures in order to adjust an implanted device to optimize patient-specific feature signals and treatment therapies, comprising the acts of:

accumulating the energy of raw intracranial electroencephalograms (IEEG) for the individual over multiple data channels during seizures over a fixed time period;

accumulating the energy of a treatment control effort over the multiple data channels over all times of activation of the implanted device over a fixed time period;

weighting the accumulated energy of the IEEG and the accumulated energy of the control effort by seizure and treatment factors to determine a quality for the fixed period of time; and

determining a quality of life index as a weighted average of a current and previous qualities for a plurality of fixed time periods.

24. The method for assessing the quality of life index of claim 23 wherein the fixed time period is a day.

25. The method for assessing the quality of life index of claim 24 wherein the quality of life index is an exponentially-weighted moving average of the daily quality which is based on a forgetting schedule to taper off the influence of older data.

26. The method for assessing the quality of life index of claim 25 wherein the forgetting schedule is designed so that the data is 98% forgotten over a period of thirty days.

27. The method for assessing the quality of life index of claim 26 wherein the quality of life index is calculated recursively using weights that are made to decay within four time constants of the natural exponential function.

28. The method for assessing the quality of life index of claim 23 wherein the seizure and treatment weights are relative weights that sum to one.

29. A method for periodic learning to improve and maintain the performance of a device implanted in an individual subject to seizures to provide treatment therapies, comprising the acts of:

assessing a quality of life index that penalizes the intensity, duration and frequency of seizures and treatments over a fixed period of time;

marking a time of unequivocal electrographic onset (UEO) in all recorded seizures over a previous fixed period of time;

creating learning sets of data based on the UEOs by clipping all the IEEG epochs immediately preceding seizures and labeling the clipped epochs as preseizure raw data;

clipping and labeling randomly chosen, non-overlapping data as non-preseizure or baseline raw data;

generating a time series of all features in a feature library from the preseizure and nonpreseizure raw data;

searching for an optimal feature vector in a power set of the feature library to minimize a classifier-based performance metric;

synthesizing a posterior probability estimator for the optimal feature vector; and

coupling an optimal therapy activation threshold to the probability estimator.

30. The method for periodic learning of claim 29 further comprising joining the preseizure and nonpreseizure raw data sets with the corresponding data sets for the three preceding fixed periods of time in order that the preseizure and nonpreseizure raw data sets have an incremental effect on learning.

31. The method for periodic learning of claim 30 wherein four preseizure and four nonpreseizure data sets correspond to a four period rectangular moving window of learning data.

32. The method for periodic learning of claim 30 wherein four preseizure and four nonpreseizure data sets correspond to a window that tapers off the last four periods according to a forgetting schedule.

33. The method for periodic learning of claim 29 further comprising preoptimizing parameters associated with a time history of signal features and thresholds using statistical measures of separability.

34. The method for periodic learning of claim 33 wherein the time history of signal features includes an observation window length, and a displacement between window slides as a feature sampling period.

35. The method for periodic learning of claim 33 wherein the thresholds include thresholds on amplitude, thresholds on duration and thresholds on density count.

36. The method for periodic learning of claim 33 wherein statistical measures of linear separability include t-scores, Fisher discriminant ratios and K-factors.

37. The method for periodic learning of claim 33 wherein statistical measures of non-linear separability include likelihood scores, probability of errors, error risk and overall risk.

38. The method for periodic learning of claim 33 further comprising generating a time series of each feature in the feature library using a short calibration epoch of preseizure and nonpreseizure data under a hypothesized set of parameters for the feature.

39. The method for periodic learning of claim 38 further comprising determining a parameter set that maximizes separability by a greedy algorithm that varies one parameter at a time.

40. The method for periodic learning of claim 33 wherein the act of searching for an optimal feature vector further comprises the acts of:

generating trajectories of candidate feature vectors by time synchronizing the time series of all features in the feature library;

synthesizing nonparametric classifiers that memorize a training data set to simulate therapy activation decision rules and accelerate feature optimization;

correcting a discriminant function of the nonparametric classifiers to determine the optimal decision rule;

measuring an overall risk over a validation set of data that is not directly used for synthesizing the nonparametric classifiers; and

determining a next candidate feature vector using a heuristic search criterion.

41. The method for periodic learning of claim 40 further comprising compressing a selected feature vector into a single genetically-found, neurally-computed artificial feature with equal or better discriminatory properties.

42. The method for periodic learning of claim 40 further comprising charting rank-order curves for overall risk for the best n vectors.

43. The method for periodic learning of claim 42 wherein the rank-order curves plot one minus the overall risk versus n.

44. The method for periodic learning of claim 40 further comprising assessing an expected performance for a next month by calculating an average overall risk using cross-validation over all available data.

45. The method for periodic learning of claim 40 further comprising assessing an expected performance for a next month by calculating an average overall risk using a single independent test set not used during the periodic learning.

46. The method for periodic learning of claim 29 wherein the act of synthesizing a posterior probability estimator further comprises the acts of:

training a wavelet neural network to calculate posterior probability estimators;

minimizing an expected value of a squared error loss function on a validation set of data; and

selecting a wavelet neural network that minimizes the error over the validation set of data.

47. The method for periodic learning of claim 46 further comprising the act of correcting the posterior probability estimator's bias term based on prior probability mismatches.

48. The method for periodic learning of claim 46 wherein the wavelet neural network includes a logistic sigmoid output unit and calculates posterior probability estimators by presenting {0,1} targets to indicate a nonseizure class and a seizure class, respectively.

49. The method for periodic learning of claim 29 further comprising the act of ranking the desirability of feature vectors using a plurality of sets of classifier-based performance metrics.

50. The method for periodic learning of claim 49 wherein a first set of classifier-based performance metrics includes a probability of a correct positive, a probability of a false negative, a probability of a correct negative, a probability of a false positive, a probability of correct classification, a probability of error, a selectivity value and a balance value.

51. The method for periodic learning of claim 49 wherein a second set of classifier-based performance metrics includes a prior probability of preseizure and a prior probability of nonpreseizure.

52. The method for periodic learning of claim 49 wherein a third set of classifier-based performance metrics includes a false positives per hour measure, an average detection delay measure, an error risk measure and an overall risk measure.

53. The method for periodic learning of claim 52 wherein the error risk measure is determined by applying penalty factors to the probability of a false negative and the probability of a false positive

54. The method for periodic learning of claim 53 wherein the penalty factor for a false negative representing a missed seizure detection is greater than the penalty factor for a false positive representing a false seizure alarm.

55. The method for periodic learning of claim 52 wherein the overall risk measure penalizes all therapy activations.

56. The method for periodic learning of claim 55 wherein the overall risk measure is determined by applying penalty factors to the probability of a false negative, the probability of a false positive, the probability of a correct positive and the probability of a correct negative.

57. The method for periodic learning of claim 56 wherein the penalty factor associated with the probability of a correct negative is set equal to zero.

58. The method for periodic learning of claim 56 wherein the relative penalty factors are small for the probability of a correct positive, medium for a false positive and very large for a false negative.

59. The method for periodic learning of claim 40 wherein the act of searching for an optimal feature vector further comprises using an optimality criterion to determine an optimal decision rule.

60. The method for periodic learning of claim 59 wherein the optimality criterion is any one of a maximum likelihood estimate, a minimum error estimate, a Neyman-Pearson criterion, a minimum error risk estimate, a minimax error risk estimate, and a minimum overall risk estimate.

61. The method for periodic learning of claim 60 wherein the Neyman-Pearson criterion is applied inverted as a decision rule for seizure detectors in which the false positive rate is minimized for a chosen constant false negative rate.

62. The method for periodic learning of claim 40 wherein the nonparametric classifiers that memorize the training data set to simulate therapy activation decision rules and accelerate feature optimization include k-nearest neighbors (kNNs), probabilistic neural networks (PNNs) and hybrids.

63. The method for periodic learning of claim 62 wherein a plurality of distances in kNNs and a plurality of kernel heights of PNNs are weighted with forgetting factors according to the periods of time in which the training data is collected.

64. The method for periodic learning of claim 40 wherein the act of correcting a discriminant function of the nonparametric classifier includes the act of applying a correction factor to the discriminant function to correct for prior probability mismatches between the a priori probability of seizure estimated from data and the true probability of seizure.

65. The method for periodic learning of claim 29 wherein the act of searching for an optimal feature vector includes the act of performing a forward sequential search through the feature library.

66. The method for periodic learning of claim 65 wherein the forward sequential search includes the acts of:

determining a score for each feature in the feature library;

selecting as a first feature, the feature that has the highest score and adding it to the feature vector;

selecting as a second feature, the feature among the remaining features in the feature library that works best in conjunction with the first feature;

selecting the additional features required sequentially to complete the feature vector by selecting among the remaining features, the feature that works best in conjunction with all previously selected features.

67. The method for periodic learning of claim 29 wherein the act of searching for an optimal feature vector includes the act of performing an add-on, knock-out search through the feature library.

68. The method for periodic learning of claim 67 wherein the add-on, knock-out search includes the acts of:

determining a score for each feature in the feature library;

performing a forward sequential search to select m candidate features one at a time and adding each to the feature vector;

removing n worst candidate features from the feature vector, where n is less than m;

repeating the performing and removing acts iteratively until k features are selected for the feature vector.

69. A computer readable medium containing a computer program product for automatically predicting and preventing the electrographic onset of a seizure in an individual, the computer program product comprising:

program instructions that monitor a plurality of signals indicative of the activity of the brain of the individual;

program instructions that extract a set of features from the signals and form an optimal feature vector;

program instructions that synthesize a probability vector based on the optimal feature vector as an estimator of the likelihood of seizure for a plurality of prediction time intervals; and

program instructions that prevent the electrographic onset of a seizure by initiating the automatic application of at least one intervention measure that is commensurate with the likelihood of seizure.

70. The computer program product for automatically predicting and preventing the electrographic onset of a seizure of claim 69 further comprising program instructions that display the probability vector of oncoming seizures for a plurality of prediction time intervals to indicate both the time frame when the electrographic onsets are expected to occur and a degree of confidence in the predictions of electrographic onsets.

71. The computer program product for automatically predicting and preventing the electrographic onset of a seizure of claim 69 wherein the program instructions that prevent the electrographic onset of seizures initiate the automatic application of the minimally required intervention measure thereby minimizing associated side effects.

72. The computer program product for automatically predicting and preventing the electrographic onset of a seizure of claim 71 wherein the minimally required intervention measure that is initiated couples minimally invasive benign therapies to long prediction time intervals, aggressive therapies to short prediction time intervals and gradually

varying moderate forms of therapy to prediction time intervals that are between the long and short prediction time intervals.

73. The computer program product for automatically predicting and preventing the electrographic onset of a seizure of claim 69 wherein the intervention measure that is initiated includes at least one of cognitive stimulation, sensory stimulation, biofeedback, electrical stimulation and pharmacological infusion.

74. The computer program product for automatically predicting and preventing the electrographic onset of a seizure of claim 69 further comprising program instructions that apply a closed loop feedback control law and command a therapy actuator in order to regulate the seizure probability vector.

75. The computer program product for automatically predicting and preventing the electrographic onset of a seizure of claim 74 wherein the applied closed loop feedback control law and therapy actuator that is applied includes any of a proportional, proportional-integral-derivative (PID), optimal continuous, gain scheduled, multilevel and bang-bang control strategies to regulate the seizure probability vector as a controlled variable.

76. A computer readable medium containing a computer program product for assessing a quality of life index in an individual subject to seizures in order to adjust an implanted

device to optimize patient-specific feature signals and treatment therapies, the computer program product comprising:

program instructions that accumulate the energy of raw intracranial electroencephalograms (IEEG) for the individual over multiple data channels during seizures over a fixed time period;

program instructions that accumulate the energy of a treatment control effort over the multiple data channels over all times of activation of the implanted device over a fixed time period;

program instructions that weight the accumulated energy of the IEEG and the accumulated energy of the control effort by seizure and treatment factors to determine a quality for the fixed period of time; and

program instructions that determine a quality of life index as a weighted average of a current and previous qualities for a plurality of fixed time periods.

77. The computer program product for assessing a quality of life index of claim 76 further comprising program instructions that determine the quality of life index as an exponentially-weighted moving average of the daily quality which is based on a forgetting schedule to taper off the influence of older data.

78. The computer program product for assessing the quality of life index of claim 77 wherein the program instructions that determine the quality of life index calculate the index recursively using weights that are made to decay within four time constants of the natural exponential function.

79. A computer readable medium containing a computer program product for periodic learning to improve and maintain the performance of a device implanted in an individual subject to seizures to provide treatment therapies, the computer program product comprising:

program instructions that assess a quality of life index that penalizes the intensity, duration and frequency of seizures and treatments over a fixed period of time;

program instructions that collect a time of unequivocal electrographic onset (UEO) in all recorded seizures over a previous fixed period of time;

program instructions that create learning sets of data based on the UEOs by clipping all the IEEG epochs immediately preceding seizures and labeling the clipped epochs as preseizure raw data;

program instructions that clip and label randomly chosen, non-overlapping data as non-preseizure or baseline raw data;

program instructions that generate a time series of all features in a feature library from the preseizure and nonpreseizure raw data;

program instructions that search for an optimal feature vector in a power set of the feature library to minimize a classifier-based performance metric;

program instructions that synthesize a posterior probability estimator for the optimal feature vector; and

program instructions that couple an optimal therapy activation threshold to the probability estimator.

80. The computer program product for periodic learning of claim 79 further comprising program instructions that join the preseizure and nonpreseizure raw data sets with the corresponding data sets for the three preceding fixed periods of time in order that the preseizure and nonpreseizure raw data sets have an incremental effect on learning.

81. The computer program product for periodic learning of claim 79 further comprising program instructions that preoptimize parameters associated with a time history of signal features and thresholds using statistical measures of linear separability.

82. The computer program product for periodic learning of claim 81 further comprising program instructions that generate a time series of each feature in the feature library using a short calibration epoch of preseizure and nonpreseizure data under a hypothesized set of parameters for the feature.

83. The computer program product for periodic learning of claim 69 further comprising program instructions that determine a parameter set that maximizes separability by a greedy algorithm that varies one parameter at a time.

84. The computer program product for periodic learning of claim 79 wherein the program instructions that search for an optimal feature vector further comprise:

program instructions that generate trajectories of candidate feature vectors by time synchronizing the time series of all features in the feature library;

program instructions that synthesize nonparametric classifiers that memorize a training data set to simulate therapy activation decision rules and accelerate feature optimization;

program instructions that correct a discriminant function of the nonparametric classifiers to determine the optimal decision rule;

program instructions that measure an overall risk over a validation set of data that is not directly used for synthesizing the nonparametric classifiers; and

program instructions that determine a next candidate feature vector using a heuristic search criterion.

85. The computer program product for periodic learning of claim 84 further comprising program instructions that compress a selected feature vector into a single genetically-found, neurally-computed artificial feature with equal or better discriminatory properties.

86. The computer program product for periodic learning of claim 84 further comprising program instructions that chart rank-order curves for overall risk for the best n-vectors.

87. The computer program product for periodic learning of claim 84 further comprising program instructions that assess an expected performance for a next month by calculating an average overall risk using cross-validation over all available data.

88. The computer program product for periodic learning of claim 84 further comprising program instructions that assess an expected performance for a next month by calculating

an average overall risk using a single independent test set not used during the periodic learning.

89. The computer program product for periodic learning of claim 84 wherein the program instructions that synthesize a posterior probability estimator further comprises:

program instructions that train a wavelet neural network to calculate posterior probability estimators;

program instructions that minimize an expected value of a squared error loss function on a validation set of data; and

program instructions that select a wavelet neural network that minimizes the error over the validation set of data.

90. The computer program product for periodic learning of claim 89 further comprising program instructions that correct the posterior probability estimator's bias term based on prior probability mismatches.

91. The computer program product for periodic learning of claim 89 wherein the wavelet neural network includes a logistic sigmoid output unit and program instructions that calculate posterior probability estimators by presenting {0,1} targets to indicate a nonseizure class and a seizure class, respectively.

92. The computer program product for periodic learning of claim 84 further comprising program instructions that rank the desirability of feature vectors using a plurality of sets of classifier-based performance metrics.

93. The computer program product for periodic learning of claim 92 wherein a first set of classifier-based performance metrics includes a probability of a correct positive, a probability of a false negative, a probability of a correct negative, a probability of a false positive, a probability of correct classification, a probability of error, a selectivity value and a balance value.

94. The computer program product for periodic learning of claim 92 wherein a second set of classifier-based performance metrics includes a prior probability of preseizure and a prior probability of nonpreseizure.

95. The computer program product for periodic learning of claim 92 wherein a third set of classifier-based performance metrics includes a false positives per hour measure, an average detection delay measure, an error risk measure and an overall risk measure.

96. The computer program product for periodic learning of claim 92 further comprising program instructions that determine the error risk measure by applying penalty factors to the probability of a false negative and the probability of a false positive.

97. The computer program product for periodic learning of claim 84 wherein the program instructions that search for an optimal feature vector further comprises program instructions that use an optimality criterion to determine an optimal decision rule.

98. The computer program product for periodic learning of claim 97 wherein the optimality criterion is any one of a maximum likelihood estimate, a minimum error estimate, a Neyman-Pearson criterion, a minimum error risk estimate, a minimum error risk estimate, and a minimum overall risk estimate.

99. The computer program product for periodic learning of claim 98 wherein the Neyman-Pearson criterion is applied inverted as a decision rule for seizure detectors in which the false positive rate is minimized for a chosen constant false negative rate.

100. The computer program product for periodic learning of claim 84 wherein the nonparametric classifiers that memorize the training data set to simulate therapy activation decision rules and accelerate feature optimization include k-nearest neighbors (kNNs), probabilistic neural networks (PNNs) and hybrids.

101. The computer program product for periodic learning of claim 100 further comprising program instructions that weight a plurality of distances in kNNs and a plurality of kernel height of PNNs with forgetting factors according to the periods of time in which the training data is collected.

102. The computer program product for periodic learning of claim 84 wherein the program instructions that correct a discriminant function of the nonparametric classifier includes program instructions that apply a correction factor to the discriminant function to correct for prior probability mismatches between the a priori probability of seizure estimated from data and the true probability of seizure.

103. The computer program product for periodic learning of claim 84 wherein program instructions that search for an optimal feature vector includes program instructions that perform a forward sequential search through the feature library.

104. The computer program product for periodic learning of claim 103 wherein the program instructions that perform a forward sequential search includes:

program instructions that determine a score for each feature in the feature library;

program instructions that select as a first feature, the feature that has the highest score and adding it to the feature vector;

program instructions that select as a second feature, the feature among the remaining features in the feature library that works best in conjunction with the first feature; and

program instructions that select the additional features required sequentially to complete the feature vector by selecting among the remaining features, the feature that works best in conjunction with all previously selected features.

105. The computer program product for periodic learning of claim 79 wherein the program instructions that search for an optimal feature vector includes program instructions that perform an add-on, knock-out search through the feature library.

106. The computer program product for periodic learning of claim 105 wherein the program instructions that perform the add-on, knock-out search includes:

program instructions that determine a score for each feature in the feature library;

program instructions that perform a forward sequential search to select m candidate features one at a time and add each to the feature vector;

program instructions that remove n worst candidate features from the feature vector, where n is less than m; and

program instructions that repeat the performing and removing program instructions iteratively until k features are selected for the feature vector.

107. A system for automatically predicting and preventing the electrographic onset of a seizure in an individual, comprising:

a signal acquisition component to condition and digitize a plurality of raw signals received from a transducer implanted in the individual;

a preprocessor to attenuate any artifacts in the plurality of digitized signals;

a feature extraction component containing processing logic to select patient-specific seizure-predictive and seizure-indicative attributes from the preprocessed signals to form an optimal feature vector;

a probability estimator component that synthesizes a probability vector as an estimator of the likelihood of seizure for a plurality of prediction times;

a multitherapy activation component containing processing logic to determine the therapy modalities that are to be activated or deactivated at any time; and

an implanted device including a plurality of therapy actuators to automatically activate at least one associated therapy in response to an output signal from the multitherapy activation component.

108. The system for automatically predicting and preventing the electrographic onset of a seizure of claim 107 wherein the therapies associated with the plurality of therapy actuators include one or more of cognitive stimulation, sensory stimulation, biofeedback, electrical stimulation and pharmacological infusion.

109. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 107 wherein the preprocessor is implemented in any one or more of a microprocessor, a digital signal processor, a field programmable gate array, an application specific integrated circuit, and a hybrid analog/digital circuit.

110. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 107 wherein the feature extraction component is implemented in any one or more of a microprocessor, a digital signal processor, a field programmable gate array, an application specific integrated circuit, and a hybrid analog/digital circuit.

111. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 107 wherein the probability estimator component is implemented in any one or more of a microprocessor, a digital signal processor, a field programmable gate array, an application specific integrated circuit, and a hybrid analog/digital circuit.

112. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 107 wherein the multitherapy activation component is implemented in any one or more of a microprocessor, a digital signal processor, a field programmable gate array, an application specific integrated circuit, and a hybrid analog/digital circuit.

113. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 107 wherein the plurality of therapy actuators are programmed to operate in an open loop mode, delivering prophylactic treatment by any one of a button, a magnet, and a vibration transducer.

114. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 107 wherein the plurality of therapy actuators are programmed to operate in a closed loop mode, using any one of a proportional, a proportional-integral-derivative, an optimal continuous, a gain-scheduled, a multilevel, and a bang-bang feedback control strategy.

115. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 107 further comprising an external storage for storing the digitized signals processed by the signal acquisition component.

116. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 107 further comprising a wearable access device to display the probability vector of oncoming seizures and the multitherapy activation status to the individual.

117. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 107 wherein the implanted device further includes an electronically erasable programmable read-only memory for downloading a plurality of learned algorithms and parameters received via transceivers.

118. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 107, further comprising a processor including a centralized learning and programming interface logic for simulating the actions of the feature extraction component, probability estimator component, and multitherapy activation component in order to improve the performance of each component.

119. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 118 wherein the processor is a laptop or workstation computer.

120. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 119 wherein the laptop or workstation computer is at a location different from that of the individual.

121. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 118 wherein the processor is located at a remote facility that is accessible over the Internet via a T1 line or other high speed digital link.

122. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 107 wherein the plurality of therapy actuators automatically apply the minimally required intervention measure, thereby minimizing associated side effects.

123. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 122 wherein the minimally required intervention measures starts with a benign form of therapy and continues with more aggressive therapies as the probability vector continuously changes with decreasing time to electrographic onset.

124. The system for automatically predicting and controlling the electrographic onset of a seizure of claim 122 wherein the minimally required intervention measures couples minimally invasive benign therapies to long prediction time intervals, aggressive therapies to short prediction time intervals and gradually varying moderate forms of therapy to prediction time intervals that are between the long and short prediction time intervals.

125. A system for assessing a quality of life index in an individual subject to seizures in order to adjust an implanted device in order to optimize patient-specific feature signals and treatment therapies comprising:

a signal acquisition component to condition and digitize a plurality of raw signals received on multiple data channels from a transducer implanted in an individual;

a first storage for accumulating the energy of raw intracranial electroencephalograms (IEEG) for the individual on multiple data channels during seizures over a fixed time period;

a second storage for accumulating the energy of a treatment control effort on the multiple data channels over all times of activation of the implanted device over a fixed time period;

a processor including:

a first logic module for weighting the accumulated energy of the IEEG and the accumulated energy of the control effort by seizure and treatment factors to determine a quality for the fixed period of time; and

a second logic module for determining a quality of life index as a weighted average of a current and previous qualities for a plurality of fixed time periods.

126. The system for assessing the quality of life index of claim 125 wherein the second logic module for determining the quality of life index uses an exponentially-weighted moving average of the daily quality which is based on a forgetting schedule to taper off the influence of older data.

127. A system for periodic learning to improve and maintain the performance of a device implanted in an individual subject to seizures in providing treatment therapies comprising:

a signal acquisition component to condition and digitize a plurality of raw signals received from a transducer implanted in the individual;

a processor coupled to the signal acquisition component and including a learning and training module for:

assessing a quality of life index that penalizes the intensity, duration and frequency of seizures and treatments over a fixed period of time;

marking a time of unequivocal electrographic onset (UEO) in all recorded seizures over a previous fixed period of time;

creating learning sets of data based on the UEOs by clipping all the IEEG epochs immediately preceding seizures and labeling the clipped epochs as preseizure raw data;

clipping and labeling randomly chosen, non-overlapping data as non-preseizure or baseline raw data;

generating a time series of all features in a feature library from the preseizure and nonpreseizure raw data;

searching for an optimal feature vector in a power set of the feature library to minimize a classifier-based performance metric;

synthesizing a posterior probability estimator for the optimal feature vector; and

coupling an optimal therapy activation threshold to the probability estimator.

128. The system for periodic learning of claim 127 wherein the learning and training module further comprises programming logic for:

generating trajectories of candidate feature vectors by time synchronizing the time series of all features in the feature library;

synthesizing nonparametric classifiers that memorize a training data set to simulate therapy activation decision rules and accelerate feature optimization;

correcting a discriminant function of the nonparametric classifiers to determine the optimal decision rule;

measuring an overall risk over a validation set of data that is not directly used for synthesizing the nonparametric classifiers; and

determining a next candidate feature vector using a heuristic search criterion.

129. The system for periodic learning of claim 127 wherein the learning and training module further comprises programming logic for:

training a wavelet neural network to calculate posterior probability estimators;

minimizing an expected value of a squared error loss function on a validation set of data; and

selecting a wavelet neural network that minimizes the error over the validation set of data.

130. The system for periodic learning of claim 127 wherein the learning and training module further comprises programming logic for ranking a desirability of feature vectors using a plurality of sets of classifier-based performance metrics.

131. The system for periodic learning of claim 130 wherein a first set of classifier-based performance metrics includes a probability of a correct positive, a probability of a false negative, a probability of a correct negative, a probability of a false positive, a probability of correct classification, a probability of error, a selectivity value, and a balance value.

132. The system for periodic learning of claim 130 wherein a second set of classifier-based performance metrics includes a prior probability of preseizure and a prior probability of nonpreseizure.

133. The system for periodic learning of claim 130 wherein a third set of classifier-based performance metrics includes a false positives per hour measure, an average detection delay measure, an error risk measure, and an overall risk measure.

134. The system for periodic learning of claim 133 wherein the overall risk measure is determined by applying penalty factors to the probability of a false negative, the probability of a false positive, the probability of a correct positive, and the probability of a correct negative.

135. The system for periodic learning of claim 128 wherein the learning and training module further comprises programming logic for determining an optimal decision rule based on a selected optimality criterion.

136. The system for periodic learning of claim 135 wherein the optimality criterion is any one of a maximum likelihood estimate, a minimum error estimate, a Neyman-Pearson criterion, a minimum error risk estimate, a minimax risk estimate, and a minimum overall risk estimate.